involved, as in the case of instinct. This "may give the reason, e. g., that instincts are so often coterminous with the limits of species. Similar structures find the similar uses for their intelligence, and they also find the same imitative actions to be to their advantage. So the interaction of these conscious factors with natural selection brings it about that the structural definition which represents species, and the functional definition which represents instinct, largely keep to the same lines" (ref. 5).

6. It seems proper, therefore, to call the influence of Organic Selection "a new factor;" for it gives a method of deriving the determinate gains of phylogeny from the adaptations of ontogeny without holding to either of the two current theories. *The ontogenetic adaptations are really new, not performed; and they are really reproduced in succeeding generations, although not physically inherited.*

(*To be continued.*)

THE PATH OF THE WATER CURRENT IN CUCUMBER PLANTS.

By Erwin F. Smith.

(*Continued from page 378*).

2. Upward Movement of One Per Cent. Eosine Water Through Cut Stems Plugged with Gelatine.

In all of these experiments a somewhat stiff gelatine was used (15 per cent.) to secure a relatively high melting point (about 27° C.) and this was tinged with India ink, so that the location of the gelatine plugs inside of the vessels could be determined accurately on cross section. Both substances being as far as has been determined inert to the plant, it is not likely that they could have in any way injured the carrying capacity of the walls of the vessels.[2]

[2]Recently Dixon and Joly (Annals of Botany, Sept., 1895, p. 403) have raised some objections to this view, but it cannot be said that they have fully established their case.

(No. 5). A much branched large vine, bearing many leaves, at least 60, the breadth of the best ones being 17 cm. The distance from the cut stem to the extremity of the longest shoot measured 218 centimeters. March 20, 1:52 p. m. The basal part of the stem was plunged into gelatine at 45° C., severed smoothly and left 40 minutes, the temperature of the gelatine when the cut stem was removed being 34° C. At 1:30 p. m. the dry bulb registered 18° C, and the wet bulb 16.5° C., and transpiration during the afternoon was probably not very active. On removing the cut stem from the melted gelatine, it was immediately plunged into water at 16° C., and kept there 10 minutes, i. e., until the gelatine was congealed. At 2:38 p. m. the stem was shortened about 3 millimeters and plunged into 1 per cent eosine water at a temperature of 16° C. A careful examination of the 3 millimeter segment showed that by far the larger number of the vessels of the stem (nearly all) were full of the black gelatine, but for unknown reasons, some of the spirals and a very few of the larger pitted vessels were not filled. 4:10 p. m. No trace of color in the veins of any of the leaves. 4:50 p. m. Not a trace of color in any of the leaves. The stem has now been in the eosine water 2 hours and 12 minutes. March 21, 11:30 a. m. The house is dryer than yesterday, and the demand on the plant for water is enormous. The foliage is shriveled or flabby, including the petioles,and hangs down, but not a trace of eosine is to be seen anywhere in any of the leaves, although the lowest leaf is within 24 centimeters of the cut end. There has also been no perceptible lowering of the level of the eosine water in which the stem rests. The sun shines hot through the glass, the temperature in the shade on a level with the bench being 24° C., while in the sun, four inches above, it is 29° C. 12:20 p. m. No trace of eosine visible externally in any part of stem or leaves, although it is nearly 22 hours since the stem was plunged into the stain. The stem was now removed and cut for examination with the following results: 2 cm. up.—There is a trifling stain. Nearly all of the vessels are full of gelatine, and in some of the bundles the stain shows *only in those spirals which did not fill.* 4 cm.

up.—Most of the vessels are full of gelatine. 8 cm. up.—About one-third of the vessels are full. 12 cm. up.—No gelatine in the vessels. Three of the nine bundles show no trace of stain. There is no fluid in the lumen of any of the vessels of the other 6 bundles, but the walls of the vessels and connecting tissues are partially stained in 4 bundles, and entirely in 2.30 cm. up, i. e., above several nodes.—The walls of a part of the vessels of each bundle are tinged with the stain, but less strongly than at 12 centimeters. The lignified parts of all of the spiral vessels show the stain, but part of the pitted vessels are free from stain, and all of the phloem, fundamental tissue, collenchyma and sclerenchyma. It would seem as if the spirals brought up the stain (the almost inappreciable quantity which passed by the gelatine plugs), and that from these it diffused out into the rest of the xylem. When the walls of the pitted vessels were stained, those of the connecting tracheids were also stained. 50 cm. up.—The red color is restricted to 4 inner and 2 outer bundles. In one of the two outer bundles and in all of the inner ones, the stain is confined to the region of the spirals and is barely visible in these. Longitudinal and oblique cuts also show in a striking way the restriction of the stain to the spirals. 60 cm. up.—Barest trace of stain in 3 bundles. 65 cm. up.—Only slightest trace of stain, restricted to the spirals of 2 bundles. 70 cm. up.—No trace of stain. 80 cm. up.—No trace of color. Two branches were given off just under the 50 cm. cut: In the lower there was a trace of stain in two bundles at 5 cm. from the main stem; in the the other there was no trace of the stain, 2 cm. or 5 cm. out.

Here there was every opportunity for water to pass through the walls of the vessels, the osmotic pull probably amounting to a pressure of several atmospheres, but there is no conclusive evidence that even a single drop passed up in this way. The very slight amount of eosine which passed up the stem may have gone through the walls of the vessels in obedience to the law of surface tension or may have passed through the lumina, owing to the incomplete plugging of some of the vessels, those which showed no gelatine being probably plugged by air and inoperative.

(No. 15). An old, much branched vine which has borne fruit and is nearly past profitable culture. The principal stem is 200 centimetres long (measured from the cut near the earth); the longest branch is 105 cm.; the next longest is 65 cm. The vine has lost much of its foliage but bears about 60 medium sized leaves (10 to 15 cm. broad) and as many more smaller ones, mostly from short, lateral branches, so that the transpiration on a sunny, windy day, like this, must be very considerable. March 22, 2:05 p. m. The base of the vine, which had previously been dug up carefully by the roots, and put at once into water, was cut 30 cm. above the roots under gelatine at a temperature of 40° C. 2:30 p. m. Many of the leaves have begun to wilt, showing that the transpiration and negative pressure must be very great. The stem was now shortened under the gelatine one centimeter and the segment examined. Most of the vessels were full of gelatine but not all. A dozen or so of the pitted vessels were empty and more than that many spirals. The vessels of some bundles appeared to be completely full including the spirals. 2:40 p. m. The foliage now shows a decided droop. Stem cut again under the still fluid gelatine 4 cm. up. Fully one-third of the pitted vessels are free from gelatine (contain air), but most of the spirals seem to be full. The torn central stem cavity is also full of gelatine and was in those examined yesterday. 3:30 p. m. Marked droop of all the foliage. Stem removed quickly from the gelatine which has been kept at 40° C. and plunged into water at 19° C. 3:50 p. m. Stem shortened slightly and put at once into 1 per cent eosine water cooled down to 14° C. An examination of the segment just removed shows that nearly all of the vessels are full of the solidified gelatine, but not *all.* 4:10 p. m. No trace of stain in any of the leaves, although those nearest the cut are only 15 centimeters up. 5:00 p. m. The vine is drooping and needs water badly, but can get none either through the walls of the vessels or through the gelatine plugs. An hour and ten minutes has passed since the stem was plunged into the eosine and yet there is not a trace of stain in any leaf, although the eosine water would have gone to the end of the vine and been dis-

tinctly visible in the veins of every leaf in 15 minutes but for the gelatine plugs, as we have seen from the preceding experiments. March 23, 11:00 a. m. Two-thirds of all the foliage of this vine is now dry-shriveled, and the remainder is very flabby, but there is not a trace of eosine visible in any of the leaves, not even in those which are near the cut end and still living. Sun shining, hot, some wind outside. Temperature in the shade, 6 inches above the bench, 27° C.; in sun, 30° C.; dry bulb, 26.5° C.; wet bulb, 22° C. Active transpiration. 1:45 p. m. Nine-tenths of the foliage is crisp-dry. No trace of color in any part of the stem or foliage. The stem was now removed from the fluid and cut for examination with the following results: One-half centimeter up.—Most of the pitted vessels were full of the black gelatine, one showed a rim of gelatine with a central air bubble. Spirals mostly not full. Diffuse stain in the parenchyma. The stain has passed through the gelatine itself in many instances (owing perhaps to its liquefaction on a. m. of March 23, when a beaker of water, in which the eosine bottle rested, became lukewarm and a beaker of gelatine on the bench near by became fluid). Six cm. up.—Comparatively few pitted vessels have gelatine in them; some of these are full, others have only a rim of gelatine around a succession of air bubbles. Eight cm. up.—The torn central stem cavity, which is still visible, contains no gelatine. A few pitted vessels contain gelatine mostly as rims around the walls, air being in the center. Ten cm. up.—No gelatine. Stain very feeble, diffused somewhat into the parenchyma. About $\frac{1}{4}$ of the pitted vessels unstained; color restricted to the spiral vessels in one bundle. Twenty cm. up.—No gelatine. Stain slight, not entirely restricted to the bundles but diffused out into the parenchyma on one side of the stem. Forty-three cm. up.—Slight traces of stain in 7 bundles, restricted to the spirals in 4; in two other bundles, only the outer angle of the xylem wedge is stained, on one side or the other, *i. e.*, those vessels which frequently fill with bacteria in advance of the rest of the pitted vessels, when the plant suffers from cucumber wilt. Seventy-five cm. up.—Stain restricted to six bundles, and very slight; confined to the

spirals in three bundles and almost so in a fourth. Several nodes have been cut. The stain is deepest in these parts of the stem and more widespread in the walls of the pitted vessels. Ninety cm. up.—There is still a trace of stain in three bundles; in one it is restricted to the walls of the spiral vessels, in the other two it does not occur in the spirals but on one side of the xylem, midway out in one, and in the outer angle of the other. Some of the branches were also examined. The branch 65 cm. long, separated from the parent shoot only ten centimeters above the cut surface. At 20 cm. from its junction with the main shoot, 7 bundles showed a trace of stain in the xylem part; in two of these the stain was restricted to the spirals, and in the other five it seemed to have diffused outward from the spirals into the neighboring pitted vessels. Twenty-three cm. up.—Only slightest trace of stain, restricted to the spirals of one bundle. Twenty-five cm. up.—Not a trace of stain. Thë branch 105 cm. long, separated from the parent shoot 41 centimeters above the cut surface. It was first cut at the junction with the main stem. Here the stain was to be seen in 7 bundles, but very slight and almost wholly restricted to the spiral vessels. Thirty cm. from the junction, *i. e.*, past several nodes.—Stain in xylem of all of the nine bundles; restricted to the spirals in 6, diffused in 3. This cut was made just above a node. The stain appears to be more restricted to the spirals in the internodes than in the nodes. Vessels empty. Sixty cm. up.—Only the slightest trace of stain in one bundle, so slight as to be readily overlooked. Sixty-five cm. up.—Color still present but so slight that no one would recognize it unless informed that stain had passed through the stem. Seventy cm. up.—All trace of the stain has disappeared.

It will be remembered that this vine was in the 1 per cent eosine water nearly 24 hours, during which time there was no perceptible lowering of the liquid, consequently all of the internal stain is readily accounted for, especially when we remember the powerful tinctive character of eosine, by the few drops of stain which managed to get past the gelatine plugs. We are warranted, therefore, in concluding that not a drop

passed up through the walls of the vessels, or if this be too strong a statement we are at least safe in saying that not enough passed up the walls to serve even most inadequately, the transpiration purposes of a single leaf, and this, perhaps, is the better forms in which to leave the statement. Neither can it be said, by way of objection that the eosine behaved differently from ordinary water for we have already seen that 1 per cent eosine water passes up unplugged stems readily, even for days and long after the stem is dead. In this case, judging from the state of the atmosphere, the temperature, and the amount of transpiring surface, (approximately 1,500 sq. cm.) at least 25 and probably 50 cubic centimeters would have been taken up by the plant in the first 24 hours but for the gelatine plugs. No explanation is open, therefore, except that the transpiration water passes up through the lumen of the vessels in the stem of the cucumber, and presumably in all other stems of similar structure, unless we assume that the gelatine passed into the walls of the vessels and destroyed their conductive power, and no one has proved this to be possible or even set forth facts rendering it probable. Considering the fact that the walls of the vessels in most plants are solid lignified structures and that the vessels are long open tubes, comparable to water pipes and in many plants probably continuous through the whole length of the stem, it would seem strange that this other view, viz. that the water passes upward through the wall itself and not through the lumen of the tube, should have ever gained credence, did we not know how often, even in science, the weight of a great name carries everything before it.

(*To be Continued.*)